

The University of the State of New York  
REGENTS HIGH SCHOOL EXAMINATION

# CHEMISTRY

Do every question on this exam and, within this test booklet, show work for each question.

You may also use separate paper to show calculations, write explanations, etc.

The “Reference Tables for Chemistry” which you may need to answer some questions in this examination are supplied separately. Be certain you have a copy of these reference tables before you begin the examination.

# Part I

Answer all 60 questions in this part. [70]

Directions (1-60): For each statement or question, select the word or expression that, of those given, best completes the statement or answers the question.

1 The molecules of which substance have the highest average kinetic energy?

- (1) He(g) at 0°C (3) HCl(g) at 40°C  
(2) CO<sub>2</sub>(g) at 20°C (4) N<sub>2</sub>(g) at 60°C

2 The temperature of 50 grams of water was raised to 50°C by the addition of 1,000 calories of heat energy. What was the initial temperature of the water?

- (1) 10°C (3) 30°C  
(2) 20°C (4) 60°C

3 Which gas will most closely resemble an ideal gas at STP?

- (1) SO<sub>2</sub> (3) Cl<sub>2</sub>  
(2) NH<sub>3</sub> (4) H<sub>2</sub>

4 When water freezes, each gram loses an amount of heat equal to its heat of

- 1 fusion 3 sublimation  
2 vaporization 4 reaction

5 Equal volumes of all gases at the same temperature and pressure contain an equal number of

- 1 molecules 3 electrons  
2 atoms 4 protons

6 Which is the electron configuration of an atom in the ground state?

- (1) 1s<sup>2</sup>2s<sup>1</sup>2p<sup>2</sup> (3) 1s<sup>2</sup>2s<sup>2</sup>3s<sup>1</sup>  
(2) 1s<sup>2</sup>2s<sup>2</sup>2p<sup>5</sup>3s<sup>2</sup> (4) 1s<sup>2</sup>2s<sup>2</sup>2p<sup>6</sup>3s<sup>1</sup>

7 An electron in an atom will emit energy when it moves from energy level

- (1) 2s to 3p (3) 2p to 3s  
(2) 2s to 2p (4) 2p to 1s

8 Which atom has a completely filled 3rd principal energy level?

- (1) Ar (3) Ca  
(2) Zn (4) K

9 The electron dot symbol : $\ddot{X}$ :<sup>-</sup> represents an ion of atom X. Atom X could be an atom of

- (1) K (3) I  
(2) H (4) S

10 Which of the following elements has the highest first ionization energy?

- (1) Li (3) K  
(2) Na (4) Rb

11 There are no known stable isotopes of the element with an atomic number of

- (1) 20 (3) 56  
(2) 38 (4) 88

12 The total number of protons found in an OH<sup>-</sup> ion is

- (1) 1 (3) 9  
(2) 8 (4) 17

13 Two atoms of element A unite to form a molecule with the formula A<sub>2</sub>. The bond between the atoms in the molecule is

- 1 electrovalent 3 nonpolar covalent  
2 ionic 4 polar covalent

14 Which bond has the greatest degree of ionic character?

- (1) H-Cl (3) Cl-Cl  
(2) I-Cl (4) K-Cl

15 Which substance will conduct electricity in both the solid phase and the liquid phase?

- (1) AgCl (3) H<sub>2</sub>  
(2) Ag (4) HCl

16 Which statement best explains why a CH<sub>4</sub> molecule is nonpolar?

- (1) C and H are nonmetals.  
(2) C and H have the same electronegativity.  
(3) CH<sub>4</sub> has a symmetrical charge distribution.  
(4) CH<sub>4</sub> is a gas at room temperature.

17 Which formula correctly represents mercury (I) chloride?

- (1) Hg<sub>2</sub>Cl (3) Hg<sub>2</sub>Cl<sub>2</sub>  
(2) HgCl<sub>2</sub> (4) Hg<sub>2</sub>Cl<sub>4</sub>

18 An example of an empirical formula is

- (1) C<sub>2</sub>H<sub>2</sub> (3) C<sub>2</sub>Cl<sub>2</sub>  
(2) H<sub>2</sub>O<sub>2</sub> (4) CaCl<sub>2</sub>

19 When the equation  $\text{H}_2 + \text{N}_2 \rightarrow \text{NH}_3$  is completely balanced using smallest whole numbers, the sum of all the coefficients will be

- (1) 6 (3) 3  
(2) 7 (4) 12

20 Which particle has the largest radius?

- (1) Cu (3) Se  
(2)  $\text{Cu}^{2+}$  (4)  $\text{Se}^{2-}$

21 Which atom may form a negative ion with the electron configuration  $1s^2$ ?

- (1) H (3) Li  
(2) He (4) Be

22 Which group is known as the halogens?

- (1) IA (3) VIIA  
(2) IIA (4) O

23 Which element exhibits both metallic and nonmetallic properties?

- (1) B (3) K  
(2) Ba (4) Kr

24 In which group are all of the elements solids at STP?

- (1) VIIA (3) VA  
(2) VIA (4) IVA

25 A white anhydrous powder that dissolves in water to form a blue aqueous solution could be

- (1)  $\text{MgSO}_4$  (3)  $\text{CuSO}_4$   
(2)  $\text{BaSO}_4$  (4)  $\text{CaSO}_4$

26 How many molecules are in 0.25 mole of  $\text{O}_2$ ?

- (1)  $12 \times 10^{23}$  (3)  $3.0 \times 10^{23}$   
(2)  $6.0 \times 10^{23}$  (4)  $1.5 \times 10^{23}$

27 A 10.0 gram sample of a hydrate was heated until all the water of hydration was driven off. The mass of anhydrous product remaining was 8.00 grams. What is the percent of water in the hydrate?

- (1) 12.5% (3) 25.0%  
(2) 20.0% (4) 80.0%

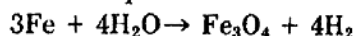
28 A compound contains 50% sulfur and 50% oxygen by mass. What is the empirical formula of the compound?

- (1) SO (3)  $\text{SO}_3$   
(2)  $\text{SO}_2$  (4)  $\text{SO}_4$

29 What is the density, in grams per liter, of  $\text{N}_2$  gas at STP?

- (1) 28.0 (3) 1.25  
(2) 14.0 (4) 0.800

30 Given the balanced equation:



What is the total number of liters of  $\text{H}_2$  produced at STP when 36.0 grams of  $\text{H}_2\text{O}$  is consumed?

- (1) 22.4 (3) 44.8  
(2) 33.6 (4) 89.6

31 What is the total number of grams of KCl (formula mass = 74.6) in 1.00 liter of 0.200 molar solution?

- (1) 7.46 g (3) 22.4 g  
(2) 14.9 g (4) 29.8 g

32 According to Reference Table G, in which reaction do the products have a higher energy content than the reactants?

- (1)  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$   
(2)  $\text{CH}_3\text{OH}(\ell) + \frac{3}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$   
(3)  $\text{NH}_4\text{Cl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{Cl}^-(\text{aq})$   
(4)  $\text{NaOH}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$

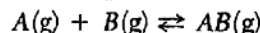
33 According to Reference Table C, which compound is most soluble in water?

- (1)  $\text{BaCO}_3$  (3)  $\text{ZnCO}_3$   
(2)  $\text{BaSO}_4$  (4)  $\text{ZnSO}_4$

34 Given the reaction  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ . What is the correct equilibrium expression for this reaction?

- (1)  $K_{eq} = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$  (3)  $K_{eq} = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]}$   
(2)  $K_{eq} = \frac{[\text{HI}]^2}{[2\text{H}][2\text{I}]}$  (4)  $K_{eq} = \frac{[\text{HI}]^2}{[\text{H}]^2[\text{I}]^2}$

35 Given the reaction at equilibrium:



Which equilibrium constant,  $K_{eq}$ , most favors the formation of  $\text{AB}(\text{g})$ ?

- (1)  $1 \times 10^{-3}$  (3)  $3 \times 10^{-9}$   
(2)  $2 \times 10^{-6}$  (4)  $4 \times 10^{-12}$

36 Based on Reference Table E, a compound which forms spontaneously from its elements is

- (1) NO (3)  $\text{C}_2\text{H}_4$   
(2)  $\text{NO}_2$  (4)  $\text{C}_2\text{H}_6$

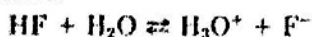
37 Which equation represents a neutralization reaction?

- (1)  $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- (2)  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$
- (3)  $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$
- (4)  $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$

38 What is the concentration of  $\text{H}_3\text{O}^+$  ions, in moles per liter, of a 0.0001 M HCl solution?

- (1)  $1 \times 10^{-1}$
- (2)  $1 \times 10^{-2}$
- (3)  $1 \times 10^{-3}$
- (4)  $1 \times 10^{-4}$

39 As HF dissolves in water, the following ionization reaction occurs:



In this reaction, a proton is donated to

- (1)  $\text{H}_3\text{O}^+$  by  $\text{H}_2\text{O}$
- (2)  $\text{H}_2\text{O}$  by HF
- (3)  $\text{H}_3\text{O}^+$  by  $\text{F}^-$
- (4) HF by  $\text{F}^-$

40 How many milliliters of 1.0 M  $\text{H}_2\text{SO}_4$  are needed to exactly neutralize 15 milliliters of 2.0 M  $\text{Ba}(\text{OH})_2$ ?

- (1) 7.5 ml
- (2) 10. ml
- (3) 15 ml
- (4) 30. ml

41 A 0.1 M solution of which acid is the best conductor of electricity at 25°C?

- (1)  $\text{H}_3\text{PO}_4$  ( $K_a = 7.1 \times 10^{-3}$ )
- (2)  $\text{HNO}_2$  ( $K_a = 5.0 \times 10^{-4}$ )
- (3)  $\text{CH}_3\text{COOH}$  ( $K_a = 1.8 \times 10^{-5}$ )
- (4)  $\text{H}_2\text{S}$  ( $K_a = 1.0 \times 10^{-7}$ )

42 What is the pH of a solution if the hydroxide ion concentration is  $1 \times 10^{-7}$  mole per liter?

- (1) 1
- (2) 7
- (3) 10
- (4) 14

43 Which is a redox reaction?

- (1)  $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$
- (2)  $\text{Mg}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{MgCl}_2 + 2\text{H}_2\text{O}$
- (3)  $\text{Mg}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2$
- (4)  $\text{MgCl}_2 + 6\text{H}_2\text{O} \rightarrow \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

44 In the reaction  $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$ , the oxidizing agent

- 1 gains protons
- 2 loses electrons
- 3 is reduced
- 4 is oxidized

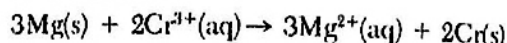
45 A chemical cell has a net reaction of  $\text{Cu} + 2\text{Ag}^+ \rightleftharpoons \text{Cu}^{2+} + 2\text{Ag}$ . At equilibrium, the cell potential, in volts, is

- (1) -0.46
- (2) 0.00
- (3) +0.34
- (4) +0.80

46 According to Reference Table L, which half-reaction has a reduction potential ( $E^\circ$ ) of +1.50 volts?

- (1)  $\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}(\text{s})$
- (2)  $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}(\text{s})$
- (3)  $\text{Sn}^{2+} + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$
- (4)  $\text{Ba}^{2+} + 2\text{e}^- \rightarrow \text{Ba}(\text{s})$

47 Given the reaction:



What is the potential ( $E^\circ$ ) for the overall reaction?

- (1) +3.11 volts
- (2) -3.11 volts
- (3) +1.63 volts
- (4) -1.63 volts

48 According to Reference Table L, which metal will react spontaneously with  $\text{H}^+$ ?

- (1) Au
- (2) Ag
- (3) Cr
- (4) Cu

49 In the reaction  $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$ , the oxidation number of nitrogen changes from

- (1) -2 to -3
- (2) -2 to +3
- (3) -3 to -2
- (4) -3 to +2

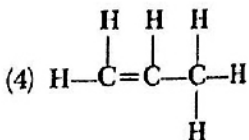
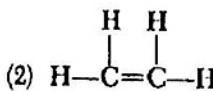
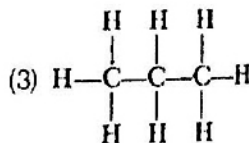
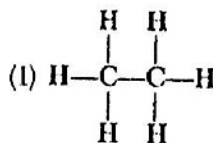
50 Which formula represents an unsaturated hydrocarbon?

- (1)  $\text{C}_3\text{H}_8$
- (2)  $\text{C}_3\text{H}_7\text{Cl}$
- (3)  $\text{C}_3\text{H}_6$
- (4)  $\text{CCl}_4$

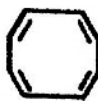
51 The isomers 1-chloropropane and 2-chloropropane differ only in

- 1 molecular composition
- 2 molecular structure
- 3 the number of chloro groups per molecule
- 4 the number of carbon atoms per molecule

52 Which structural formula represents ethene?



53 Which diagram may be used to represent a benzene ring?



(1)



(2)

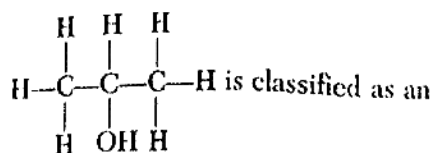


(3)



(4)

54 A compound with the structural formula



- 1 alcohol
- 2 acid

- 3 alkane
- 4 alkene

Note that questions 55 through 60 have only three choices.

- 55 As the temperature of a liquid increases, its vapor pressure
- 1 decreases
  - 2 increases
  - 3 remains the same


- 56 As a sulfur atom gains electrons, its radius
- 1 decreases
  - 2 increases
  - 3 remains the same

- 57 As the  $\text{H}_3\text{O}^+$  ion concentration of a solution increases and the  $\text{OH}^-$  concentration decreases, the pH of the solution
- 1 decreases
  - 2 increases
  - 3 remains the same

- 58 Given the system  $\text{CO}_2(\text{s}) \rightleftharpoons \text{CO}_2(\text{g})$  at equilibrium. As the pressure increases at constant temperature, the amount of  $\text{CO}_2(\text{g})$  will
- 1 decrease
  - 2 increase
  - 3 remain the same

- 59 When a catalyst lowers the activation energy of a reaction, the rate of the reaction
- 1 decreases
  - 2 increases
  - 3 remains the same

- 60 A sample of a gas is at STP. As the pressure decreases and the temperature increases, the volume of the gas
- 1 decreases
  - 2 increases
  - 3 remains the same

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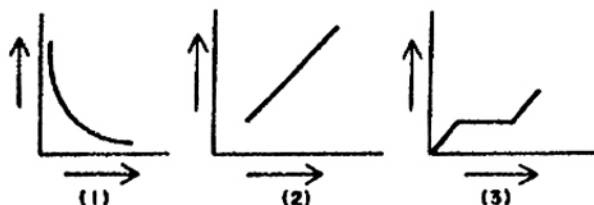
## Part II

Be sure to answer all questions in each group

### Group 1

**Directions (61–65):** Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

Base your answers to questions 61 and 62 on the graphs shown below.



Note that questions 61 and 62 have only three choices.

61 Which graph best represents how the volume of a given mass of a gas varies with the Kelvin (absolute) temperature at constant pressure?

- (1) 1  
(2) 2  
(3) 3

62 Which graph best represents how the volume of a given mass of a gas varies with the pressure exerted on it at constant temperature?

- (1) 1  
(2) 2  
(3) 3

63 Which represents a homogeneous mixture?

- (1)  $\text{CuSO}_4(\text{s})$  (3)  $\text{NaCl}(\text{aq})$   
(2)  $\text{Br}_2(\text{l})$  (4)  $\text{CO}_2(\text{g})$

64 A 16.0 gram sample of  $\text{CH}_4(\text{g})$  is at  $0^\circ\text{C}$  and 1 atmosphere. The volume of the gas sample in liters at  $27^\circ\text{C}$  and 1 atmosphere is equal to

- (1)  $16.0 \times \frac{1}{27}$  (3)  $22.4 \times \frac{273}{300}$   
(2)  $16.0 \times \frac{27}{1}$  (4)  $22.4 \times \frac{300}{273}$

65 At STP, 32 grams of  $\text{O}_2$  would occupy the same volume as

- (1) 64 g of  $\text{H}_2$  (3) 8.0 g of  $\text{CH}_4$   
(2) 32 g of  $\text{SO}_2$  (4) 4.0 g of He

### Group 2

**Directions (66–70):** Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

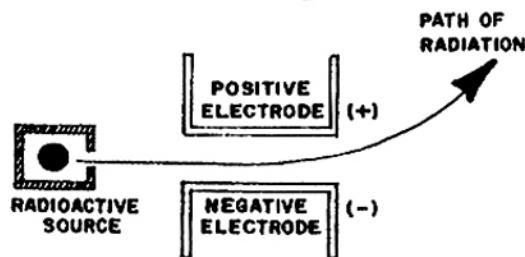
66 What is the mass number of a  $^3_1\text{H}$  atom?

- (1) 1 (3) 3  
(2) 2 (4) 4

67 Which orbital notation correctly represents the outermost principal energy level of a sulfur atom in the ground state?

	s	p		
(1)	$\uparrow\downarrow$	$\uparrow$	$\uparrow$	$\uparrow$
(2)	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow$	
(3)	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow$	
(4)	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow$	$\uparrow$

68 A radioactive source emits radiation which is deflected as shown in the diagram below.



This radiation could be

- (1)  $^0_{-1}\text{e}$  (3)  $^1_1\text{H}$   
(2)  $^4_2\text{He}$  (4)  $^1_0\text{n}$

69 In an aluminum atom in the ground state, the energy level which contains the most electrons has the principal quantum number

- (1) 1 (3) 3  
(2) 2 (4) 4

70 A fluoride ion ( $\text{F}^-$ ) has the same electron configuration as

- (1) Na (3) Cl  
(2)  $\text{Na}^+$  (4)  $\text{Cl}^-$

**Group 3**

*Directions (71–75):* Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

- 71 A compound has the empirical formula  $\text{NO}_2$ . Its molecular formula could be

(1)  $\text{NO}_2$  (3)  $\text{N}_4\text{O}_2$   
(2)  $\text{N}_2\text{O}$  (4)  $\text{N}_4\text{O}_4$

- 72 Hydrogen bonds are strongest between molecules of

(1)  $\text{HBr(g)}$  (3)  $\text{HF(g)}$   
(2)  $\text{HI(g)}$  (4)  $\text{HCl(g)}$

- 73 Which molecule is a dipole?

(1)  $\text{H}_2$  (3)  $\text{CH}_4$   
(2)  $\text{N}_2$  (4)  $\text{HCl}$

- 74 Which compound is ionic?

(1)  $\text{HCl}$  (3)  $\text{SO}_2$   
(2)  $\text{CaCl}_2$  (4)  $\text{N}_2\text{O}$

- 75 In the reaction  $\text{Al}^{3+} + 6\text{H}_2\text{O} \rightarrow \text{Al}(\text{H}_2\text{O})_6^{3+}$ , the  $\text{Al}^{3+}$  ion is undergoing the process called

1 neutralization 3 hydrogenation  
2 addition 4 hydration

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**Group 4**

*Directions (76–80):* Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

- 76 Which element forms a diatomic molecule containing a triple covalent bond?

1 hydrogen 3 nitrogen  
2 chlorine 4 oxygen

- 77 As the elements in Group IIA are considered from beryllium to radium, the degree of metallic activity

1 increases and atomic radius increases  
2 increases and atomic radius decreases  
3 decreases and atomic radius increases  
4 decreases and atomic radius decreases

- 78 Which group of elements occur only as compounds in nature because they are extremely reactive?

(1) IA (3) VIA  
(2) IB (4) O


- 79 Which element in Period 2 has the greatest tendency to gain electrons?

(1) Li (3) F  
(2) C (4) Ne

- 80 If  $M$  represents an atom of an alkali metal, the correct formula for a compound of this atom with chlorine is

(1)  $M_2\text{Cl}$  (3)  $M\text{Cl}_3$   
(2)  $M\text{Cl}_2$  (4)  $M\text{Cl}$

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### Group 5

**Directions (81–85):** Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

- 81 At STP, 170. grams of  $\text{NH}_3$  will occupy a total of  
 (1) 2.24  $\ell$  (3) 224  $\ell$   
 (2) 22.4  $\ell$  (4) 2240  $\ell$
- 82 What is the total mass of iron in 1.0 mole of  $\text{Fe}_2\text{O}_3$ ?  
 (1) 160 g (3) 72 g  
 (2) 112 g (4) 56 g
- 83 Given the reaction:  $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$   
 What is the minimum number of moles of  $\text{O}_2$  required to produce one mole of  $\text{CO}_2$ ?  
 (1) 1.0 (3) 0.25  
 (2) 2.0 (4) 0.50
- 84 A solution contains 70 grams of  $\text{NaNO}_3$  in 100 grams of water at  $10^\circ\text{C}$ . How many additional grams of  $\text{NaNO}_3$  are required to saturate this solution?  
 (1) 10 (3) 60  
 (2) 20 (4) 70
- 85 How do the freezing and boiling points of a sample of water change when 1 mole of  $\text{NaCl}$  is dissolved in it?  
 1 The freezing point decreases and the boiling point increases.  
 2 The freezing point increases and the boiling point increases.  
 3 The freezing point decreases and the boiling point decreases.  
 4 The freezing point increases and the boiling point decreases.

### Group 6

**Directions (86–90):** Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

- 86 Given the reaction at equilibrium:  
 $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{H}_2\text{O}(\text{g}) + \text{heat}$   
 The value of the equilibrium constant for this reaction can be changed by  
 1 changing the pressure 3 adding more  $\text{O}_2$   
 2 changing the temperature 4 adding a catalyst
- 87 Given the reaction at equilibrium:  
 $\frac{1}{2}\text{N}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) + 21.6 \text{ kcal} \rightleftharpoons \text{NO}(\text{g})$   
 The equilibrium will shift to the right if the  
 1 temperature increases 3 pressure increases  
 2 temperature decreases 4 pressure decreases
- 88 The heat of reaction ( $\Delta H$ ) is equal to the  
 1 heat content of the products minus the heat content of the reactants  
 2 heat content of the reactants minus the heat content of the products  
 3 entropy of the products minus the entropy of the reactants  
 4 entropy of the reactants minus the entropy of the products
- 89 Based on Reference Table E, the formation of 1 mole of which of the following substances releases the greatest amount of energy?  
 (1)  $\text{C}_2\text{H}_2$  (3)  $\text{CuSO}_4$   
 (2)  $\text{C}_2\text{H}_4$  (4)  $\text{BaSO}_4$
- 90 The reaction  
 $\text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{CH}_3\text{COO}^-(\text{aq}) + \text{H}^+(\text{aq})$   
 has a  $K_a$  equal to  $1.8 \times 10^{-5}$  at  $25^\circ\text{C}$ . In a solution of this acid at  $25^\circ\text{C}$ , the concentration of  $\text{CH}_3\text{COOH}$  is  
 1 less than the concentration of  $\text{H}^+$  ions  
 2 equal to the concentration of  $\text{H}^+$  ions  
 3 greater than the concentration of  $\text{CH}_3\text{COO}^-$  ions  
 4 equal to the concentration of  $\text{CH}_3\text{COO}^-$  ions



### Group 7

Directions (91-95): Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

- 91 The conjugate base of  $\text{NH}_3$  is  
 (1)  $\text{NH}_2^-$  (3)  $\text{NO}_3^-$   
 (2)  $\text{NH}_3$  (4)  $\text{NO}_2^-$
- 92 Which salt will hydrolyze in water to produce a basic solution?  
 (1)  $\text{BaI}_2$  (3)  $\text{CaCl}_2$   
 (2)  $\text{NaNO}_2$  (4)  $\text{MgSO}_4$
- 93 How many moles of  $\text{KOH}$  are needed to exactly neutralize 500. ml of a 1.0 M  $\text{HCl}$  solution?  
 (1) 1.0 (3) 0.25  
 (2) 2.0 (4) 0.50
- 94 In a 0.01 M solution of  $\text{HCl}$ , litmus will be  
 1 blue and phenolphthalein will be colorless  
 2 blue and phenolphthalein will be pink  
 3 red and phenolphthalein will be colorless  
 4 red and phenolphthalein will be pink
- 95 Pure water is similar to 0.1 M  $\text{HCl}$  in that they both  
 1 contain  $\text{H}_3\text{O}^+$  ions  
 2 are neutral to litmus  
 3 are good conductors of electricity  
 4 have a pH greater than 7

### Group 8

Directions (96-100): Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

- 96 Which half-reaction correctly represents reduction?  
 (1)  $\text{Sn}^{2+} + 2e^- \rightarrow \text{Sn}^{4+}$   
 (2)  $\text{Sn}^{2+} \rightarrow \text{Sn}^{4+} + 2e^-$   
 (3)  $\text{Sn}^{2+} + 2e^- \rightarrow \text{Sn}^0$   
 (4)  $\text{Sn}^{2+} \rightarrow \text{Sn}^0 + 2e^-$
- 97 Which ion is most easily oxidized?  
 (1)  $\text{Br}^-$  (3)  $\text{F}^-$   
 (2)  $\text{Cl}^-$  (4)  $\text{I}^-$
- 98 In the reaction  
 $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$ , which species is reduced?  
 (1)  $\text{Mn}^{4+}$  (3)  $\text{H}^+$   
 (2)  $\text{O}^{2-}$  (4)  $\text{Cl}^-$
- 99 During the electrolysis of fused  $\text{NaCl}$ , which half-reaction occurs at the negative electrode?  
 (1)  $\text{Na}^+ + 1e^- \rightarrow \text{Na}^0$  (3)  $2\text{Cl}^- \rightarrow \text{Cl}_2^0 + 2e^-$   
 (2)  $\text{Na}^0 \rightarrow \text{Na}^+ + 1e^-$  (4)  $\text{Cl}_2^0 + 2e^- \rightarrow 2\text{Cl}^-$
- 100 Given the reaction:  
 $\text{Cr}^{3+} + 10\text{OH}^- + \text{ClO}_3^- \rightarrow \text{CrO}_4^{2-} + \text{Cl}^- + 5\text{H}_2\text{O}$   
 When the reaction is completely balanced using the smallest whole numbers, the coefficient of  $\text{Cr}^{3+}$  will be  
 (1) 1 (3) 3  
 (2) 2 (4) 4

➡ GO RIGHT ON TO THE NEXT PAGE.

### Group 9

*Directions (101-105):* Record each answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [5]

101 Which normal alkene has the highest boiling point at 1 atmosphere?

- |              |                 |
|--------------|-----------------|
| (1) $C_2H_4$ | (3) $C_4H_8$    |
| (2) $C_3H_6$ | (4) $C_5H_{10}$ |

102 Which reaction produces ethyl alcohol as one of the principal products?

- 1 an esterification reaction
- 2 a neutralization reaction
- 3 a saponification reaction
- 4 a fermentation reaction

103 The reaction  $C_4H_{10} + Br_2 \rightarrow C_4H_9Br + HBr$  is an example of

- |                |                  |
|----------------|------------------|
| 1 substitution | 3 fermentation   |
| 2 addition     | 4 polymerization |

104 The total number of covalent bonds in a molecule of  $C_3H_8$  is

- |        |       |
|--------|-------|
| (1) 11 | (3) 3 |
| (2) 10 | (4) 8 |

105 Which compound is an ester?

- |                |                   |
|----------------|-------------------|
| (1) $CH_3COOH$ | (3) $CH_3COOCH_3$ |
| (2) $CH_3CHO$  | (4) $CH_3COCH_3$  |